DIAGNOSTIC ANGIOGRAPHY

Saadoon Kadir, M.D.

Associate Professor
Division of Cardiovascular and Interventional Radiology
The Johns Hopkins University
School of Medicine
and The Johns Hopkins Hospital
Baltimore, Maryland

1986
W. B. Saunders Company
Philadelphia — London — Toronto — Mexico City
Rio de Janeiro — Sydney — Tokyo — Hong Kong

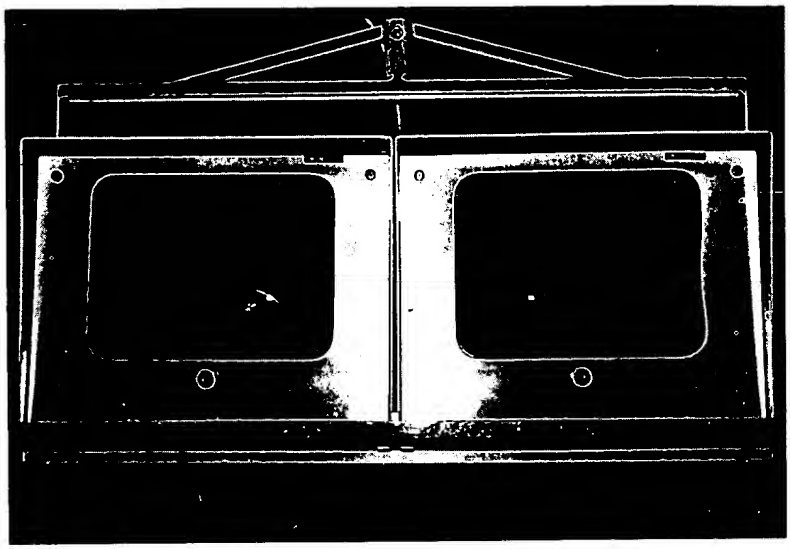


Figure 1–3. Dual ceiling-mounted television monitors for interventional and involved diagnostic angiographic procedures.

able of delivering at least 1000 to 1500 mA with a constant potential. This is necessary to permit short exposure times in order to eliminate motion artefacts and to permit rapid sequence filming in the optimal kVp range. The radiographic tube should have a high speed rotating anode with a 12° target angle and 1.2 or 0.6 mm focal spot to cover a 14 by 14 inch field size. For magnification arteriography, a smaller focal spot (0.3 mm) is necessary in order to obtain high spatial resolution. However, this reduces the field size.

A high resolution image intensifier and a television chain with the capability for magnification fluoroscopy are necessary for small vessel arteriography and interventional procedures. This capability is further enhanced by a 105 mm rapid sequence spot film device and video recording system. A digital subtraction unit can be coupled to it to complete the imaging system.

Digital subtraction angiography is fast becoming an essential part of every diagnostic radiological department. Thus, new equipment purchases should be made with due consideration of this requirement.[5]

The ideal system for fluoroscopy is a C or U arm. This permits fluoroscopy in variable planes without having to move the patient. Alternatively, a cradle can be used for this purpose. Such multiplanar fluoroscopy is often necessary to determine the location of branch vessels in the sagittal plane for selective catheterization. If the control handles for the table top, collimators, and C or U arm either can be sterilized or are covered by sterile drapes, the system could be operated by the vascular radiologist, which would free the radiological technologist for other work.

For most nonvascular and nonselective vascular procedures, a single television monitor is sufficient. For selective vascular, interventional, and involved diagnostic procedures, dual ceiling-mounted television monitors are of benefit. Images obtained by digital subtraction angiography or recorded on video tape (or disk) may be replayed and "frozen" on one monitor to serve as a guide for selective catheterization or interventional procedures. This is not necessary if a "road-mapping" program is available for the digital subtraction angiography unit.

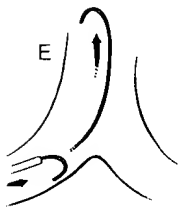
ANGIOGRAPHIC TABLE

The table top should be free floating and capable of being elevated in order to adjust to the height of the vascular radiologist and to perform magnification angiography. In combination with a C or U arm, a flat top table is used. For lower extremity arteriography, a flat top stepping table is required, unless long film changers are used. For other ceiling-mounted image intensifying systems, a cradle top is useful. A tilt table is useful, but not essential; for biliary or urinary tract and venous studies.

FILM CHANGERS (Figs. 1–4 and 1–5)

Both roll and cut film changers are available. The latter offer several advantages such as ease of handling, processing, viewing, and

: arteries. *A*, A short
he J is torqued past
pposite direction to
ver it. *D* and *E*, This



: arteries. *A*, A cobra
is. With the aid of this
ed over the wire until
a of stenosis/tortuosity
he aorta.

ful, the needle or catheter is removed and, if feasible, an attempt is made to catheterize the opposite femoral artery.

Common Errors and Problems and Their Solutions. When using any of the techniques just described, force of any kind is never necessary for advancing the guide wire. If a palpable pulse is present (even when severely diminished), this indicates the presence of a patent lumen. Therefore, when force is applied during guide wire manipulation, the course of the wire is usually outside the true lumen. If these techniques are not successful, the indications for arteriography should be reevaluated, and on the basis of that decision either another approach (TLA, axillary) or intravenous DSA may be performed.

If catheterization of such severe stenoses is successful, they may be treated by balloon angioplasty to insure continued patency.

Other problems include:

1. The use of guide wires without a tapered or movable core: The 5 cm flexible segment in these wires will often traverse the most proximal bend. The stiff core prevents the wire from going any farther.

2. The catheter will not advance over the guide wire: This is a relatively frequent problem when high torque, relatively stiff-walled (braided) catheters are used in severely tortuous arteries. When an attempt is made to thread such a catheter over the guide wire placed in the aorta, the guide wire will often retract or the catheter cannot be advanced. This situation may be avoided if thin-walled, flexible, high flow catheters (Mallinckrodt; Cook, Inc.) or heavy duty guide wires (wires with a stiffer core) are used.

TECHNIQUE FOR SELECTIVE CATHETERIZATION

After the catheter for selective catheterization has been inserted into the aorta, a 12 ml plastic syringe filled with 60% contrast medium is attached to the two-way stopcock at the catheter hub and air bubbles are eliminated from the connection. This makes it possible to inject contrast medium without having to aspirate the air bubbles each time. However, in most instances, contrast medium should be injected only if blood can be aspirated.

The catheter configurations required for catheterization of the different branches are described earlier in this chapter (see Guide Wire and Catheter Selection) and in the specific chapters dealing with those vessels. High torque catheters with good "memory" (ie, that retain the preformed shapes at body temperature) are required for selective catheterization. On the other hand, because of their relative stiffness, such catheters may not be well suited for catheterization of the third- and fourth-order branches.

Some of the prerequisites for selective catheterization are (1) knowledge of the vascular anatomy and its variations, (2) the ability to recognize the vessel selected, and (3) familiarity with alternative methods and techniques.

Basic Catheter Motions (Fig. 3–25)

The basic seeking motions with a selective catheter are as follows: From the femoral approach, the catheter tip is placed approximately 5 cm above the anticipated origin of the vessel to be catheterized and is pointed

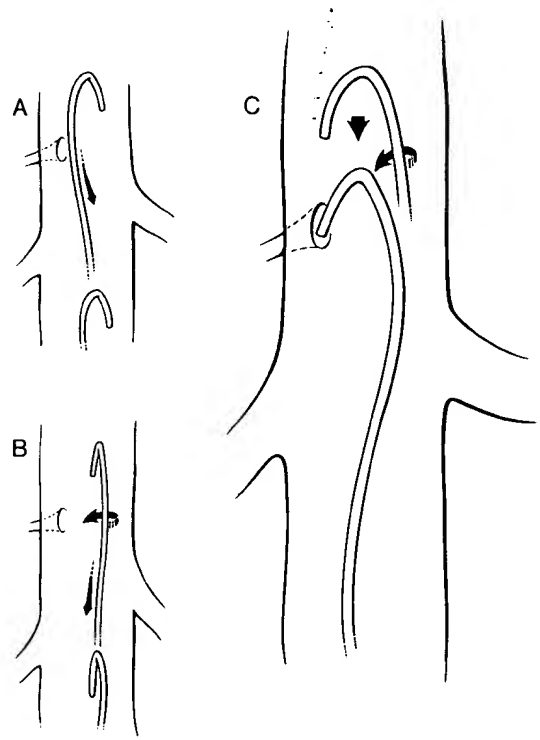


Figure 3–25. Basic catheter motions for selective catheterization. *A*, The catheter tip is placed several centimeters above the anticipated location of the orifice of the vessel to be catheterized. The catheter is slowly withdrawn at the groin. *B* and *C*, if the orifice is not found, the catheter is readvanced, the tip is rotated in a slightly different direction, and the maneuver is repeated until the tip engages the desired vessel.

in the direction of that vessel. Under fluoroscopic observation, the catheter is slowly withdrawn at the groin in a smooth, continuous motion. As the catheter enters a branch, the tip either appears to drop forward (larger branches) or gets "hooked" onto a tight orifice. If the catheter is withdrawn farther at the groin, the tip tends to straighten out.

Once a catheter has entered a branch, a small volume of contrast medium is injected (approximately 0.5 to 1 ml) in an attempt to identify the vessel. The catheter should not be advanced into any vessel unless the vessel has been identified by contrast injection. This avoids contrast injection in a wedged position. If a small branch has been catheterized (eg, lumbar, phrenic, or accessory renal artery), the vessel is well opacified by this volume of contrast medium. Injection of contrast medium into the phrenic and lumbar arteries can be very painful. Thus, if one of these vessels is not the desired artery, the catheter should immediately be withdrawn from the orifice. This permits antegrade blood flow to wash out the contrast medium and alleviate the pain.

If a large vessel (superior mesenteric or renal artery) has been catheterized, such a contrast injection does opacify the vessel sufficiently to permit identification. A larger contrast injection then confirms catheter position.

If the catheter does not enter the appropriate vessel, it is readvanced to above the anticipated location of the vessel. The direction of the catheter tip is turned slightly and the maneuver is repeated.

Once the desired vessel has been entered, the catheter is advanced into it to provide a stable position. The catheter is taped to the skin at the entry site to prevent dislodgment. Subsequently, a small test injection is used to reconfirm the catheter position and/or to check the stability of the catheter in that position (see later section of this chapter on Miscellaneous Techniques).

Aids for Selective Catheterization

1. Filling the catheter lumen with contrast medium renders it radiopaque and thus easier to identify fluoroscopically.
2. For the catheterization of laterally oriented vessels, the anterior-posterior position (of the patient or the image intensifier) should be used.
3. For catheterization of vessels with an anterior or oblique course, the patient (on the cradle table top or with the aid of a large wedge-shaped sponge if a flat table top is used) or the image intensifier C or U arm is obliqued by 25 to 30°. This facilitates identification of both the direction of the catheter tip (ie, anterior versus posterior) and the vessel orifice.
4. To determine the location of the catheter tip in the anterior-posterior projection, the tip is observed fluoroscopically as the catheter is twisted at the groin in a clockwise direction. If the catheter tip turns to the patient's left, the tip is anteriorly located. If it turns towards the patient's right, the tip points posteriorly.

Common Errors and Problems and Their Solutions

1. Attempting to torque the catheter while it is stationary: Unless the catheter is in motion (along its longitudinal axis) at the same time as it is torqued, it may not respond appropriately to the torque. By simply twisting the catheter at one level, it will accumulate torque, and after several twists, it will whip around to uncoil itself. The high torque 7 Fr cobra and sidewinder catheters may be an exception.
2. Cranio-caudad seeking motion too slow: The appropriate seeking speed is approximately 1 cm/sec. If the catheter motion is much slower than this, the aortic pulsations, which also move the catheter back and forth, may make it difficult to identify when the catheter is in a selective position (without the aid of contrast injections).
3. Continuous hand injections of contrast medium into the aorta during selective catheterization in an attempt to identify the orifice of the aortic branches: This is not recommended as routine practice for the larger branches of the aorta (eg, mesenteric, celiac, or renal arteries). If this technique is employed routinely, large volumes of contrast medium may be used before the filming is begun, which would limit the study or impair renal function. This is acceptable practice only after an attempt at selective catheterization, with the techniques described earlier, has been unsuccessful. This technique may also be used for catheterization of some smaller branches (eg, bronchials, inferior phrenic trunk off the aorta, or subclavian artery branches). It is also helpful during catheterization of the right gonadal vein and during venous sampling.
4. Failure to evaluate the position after the catheter has been taped at the skin entry site: Even a well-seated high torque catheter may

be dislodge
advance int
secured at
time a cath
other than
rechecked.

5. Use of
teriography
the orifice:
orifice of an
for stability
of contrast
later section
Techniques)

6. Is an a
lective arteri
indicated to
identify the
aortic branch
the procedur